

MRI compatible motion platform

Date: 02/23/2024 – 02/29/2024

Client: Jiayi Tang

Advisor: Dr. Trevathan

Team:

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Problem statement

MRI phantoms used to test and calibrate MRI's are often static models of the human body. These static models don't give a good representation of the constant motion created from natural processes such as respiratory and digestive functions. To solve this, our team will work on a MR compatible device that will hold a phantom and simulate the movements found within the human body.

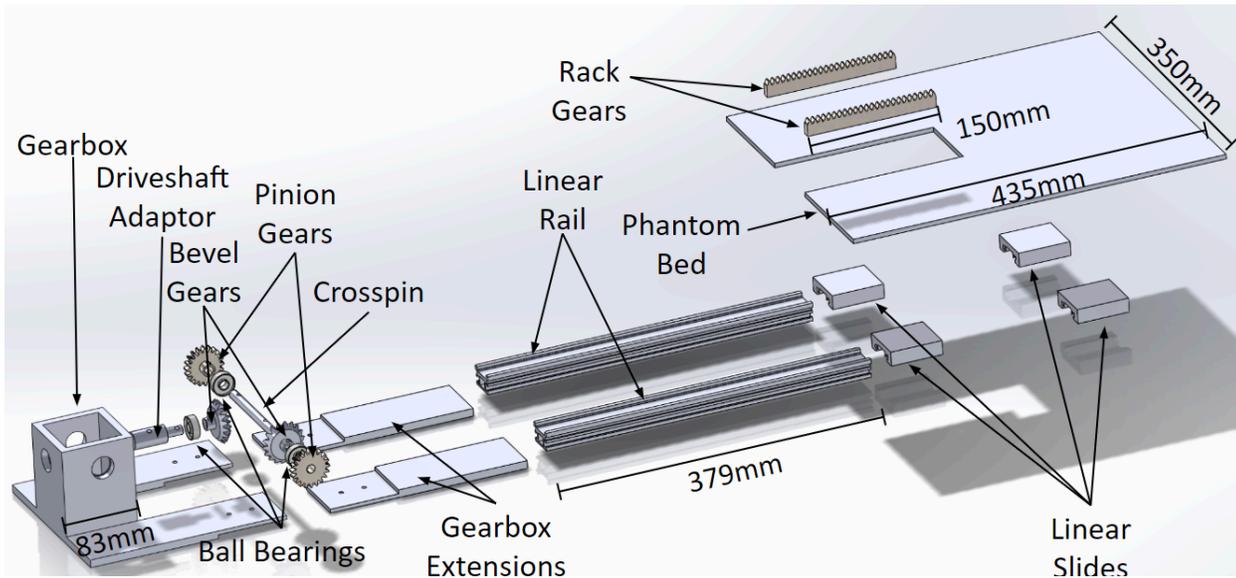
Brief status update

As for the motor control, the team met with our advisor and a UW research associate to help troubleshoot issues with the microcontroller. The team concluded that an additional step-down amplifier circuit along with a low-pass filter is necessary to get a better signal from the microcontroller to the motor control board. The team began to work on a circuit to output the desired gain and cutoff frequency.

Difficulties / advice requests

N/A

Current design



Materials and expenses

Item	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
Component 1								
Ultimaker PLA (37.0 g)	3D printed gears to translate and facilitate motion	Ultimaker	RAL-9010	10/26/2023	3	\$2.96	\$2.96	N/A
Ultimaker PLA (325.0 g)	3D printed gears and gearbox	Ultimaker	RAL-9005	11/03/2023	1	\$26.00	\$26.00	N/A
Bamboo Labs PLA (127.34 g)	3D printed gearbox extension pieces	Bambu Lab	#000000	11/15/2023	1	\$12.19	\$12.19	N/A

Ultimaker PLA (118 g)	3D printed support for the driveshaft	Ultimaker	RAL-9005	11/17/2023	1	\$9.44	\$9.44	N/A
Ultimaker PLA (27 g)	3D printed racks	Ultimaker	RAL-9005	11/29/2023	1	\$2.16	\$2.16	N/A
Ultimaker PLA (126 g)	3D printed Motor Stand	Ultimaker	RAL-9005	12/01/2023	1	\$10.08	\$10.08	N/A
Component 2								
Linear Rails	400 mm linear rails	igus	CWS-06-30-400	11/13/2023	2	\$167.69	\$335.38	Link
Component 3								
Linear Slides	Slides to support platform on linear slides	igus	WWPL-06-30-06	11/13/2023	2	\$18.25	\$36.50	Link
Component 4								
Driveshaft	Connection piece between motor and gearbox	Grainger	H0400075PW1000	11/16/2023	1	\$8.00	\$8.00	Link
Component 5								

Platform	1/4 black acrylic sheet provided by Makerspace	MSC	MSC# 63391700 (no part number given similar example)	11/17/2023	1	\$20.00	\$20.00	N/A
Component 6								
Glass Ball Bearings	Glass ball bearings to allow for frictionless rotation	Grainger	MSN0459939	12/1/2023	5	\$17.07	\$85.35	N/A
Component 7 - unused features due to reprints/redesigns								
Ultimaker PLA	3D printed Gearbox	Ultimaker	RAL-9005	10/26/2023	1	\$19.36	\$19.36	N/A
Ultimaker PLA	Motor to driveshaft adapter piece	Ultimaker	RAL-9005	12/1/2023	1	\$1.12	\$1.12	N/A
Ultimaker PLA	Motor to driveshaft adapter piece reprint	Ultimaker	RAL-9005	12/4	1	\$2.84	\$2.84	N/A
Ultimaker PLA	Motor to driveshaft adapter piece reprint	Ultimaker	RAL-9005	12/5	1	\$2.65	\$2.65	N/A
TOTAL:	\$574.03							

Major team goals for the next week

1. Continue research for the redesign and prototype improvement
 - a. Kendra and Amber - Design and build op amp circuit with LP filter. Test implementation between microcontroller and motor controller.
 - b. Max, Jamie, and Caspar - Finalize algorithm to define gearbox limitations
2. Finish Checklist 1 to get access to research lab MRI

Next week's individual goals

- Max
 - Complete Checklist I for MRI access
 - Assembly Gearbox with 1.5:1 gear ratio
- Amber
 - Complete Checklist I for MRI access
 - Finalize circuit calculations
 - Build circuit
- Jamie
 - Complete Checklist I for MRI access
 - Begin assembling the prototype
- Kendra
 - Complete checklist 1 for MRI access
 - Build circuit with LP filter and noninverting amp
- Caspar
 - Complete Checklist for MRI access
 - Begin prototype assembly

Timeline

Task	Jan	Feb				March					April				May	
	26	2	9	16	23	1	8	15	22	29	5	12	19	26	3	10
Project R&D																
Empathize		X	X	X	X											
Background		X	X													
Prototyping			X	X	X											
Testings																
Deliverables																
Progress Reports		X	X	X	X											
Prelim presentation			X		X											
Final Poster																
Meetings																
Client		X														
Advisor	X	X	X	X	X											

Website																	
Update	X	X	X	X	X												

Filled boxes = projected timeline
 X = task was worked on or completed

Previous week's goals and accomplishments

- Max
 - Watched MRI Safety Video
 - Solidworks modifications to gears with Jamie
 - Drafted report and printed prototype with team
 - Wrote 'MRI-Compatible Motion Platform' section in 'Methods' & 'Results & Discussion' for Preliminary Journal entry
 - Edit Preliminary Journal with team
 - HIPPA Training
 - Reprint Gearbox
- Amber
 - Began designing step-down amplifier circuit with low pass filter
 - Read the "ACR 2020 Manual on MRI Safety" & completed HIPPA training
 - Wrote "Characterization of Motion" and "Preliminary Sinusoidal Motion Test" sections of Results & Discussion portion of the preliminary report
 - Edited report with team
- Jamie
 - Met with Max to redesign the gears to account for different gear ratios
 - Read the "ACR 2020 Manual on MRI Safety" & completed HIPPA training
 - Wrote "Characterization of Motion" and "Preliminary Sinusoidal Motion Test" sections of Methods portion of the preliminary report
 - Edited report with team
- Kendra
 - Completed train modules for HIPPA an MRI safety
 - Met with amber to talk over the LP RC circuit with a non inverting amplifier
 - Updated PDS and organized the introduction in the preliminary deliverables
 - Edited preliminary report with team
 - Updated lab archives notebook
- Caspar
 - Wrote Conclusion and Future tests portion of preliminary report
 - Reviewed report
 - Reviewed MRI safety checklist

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Max	1/26/24	Semester planning with team	1.5	9.5	21.5
	1/31/24	Client meeting	0.5		
	2/2/24	Team meeting to review future fabrication	1.0		
	2/2/24	Team presentation assignments	0.5		
	2/6/24	Modeled future design in solidworks	1.5		

	2/6/24	Worked on preliminary presentation	1.0		
	2/7/24	Reviewed preliminary presentation with team	1.0		
	2/12/24	Reidentified desirable producible sinusoid	1.0		
	2/14/24	Met with team to order screws, and calculate gearing ratio	2.0		
	2/16/24	Team meeting to clarify torque transmission	1.0		
	2/20/24	Gearbox outputs algorithm	1.0		
	2/22/24	Watched MRI Safety Video	1.0		
	2/22/24	Solidworks modifications to gears	2.5		
	2/23/24	Drafted report and printed prototype with team	1.5		
	2/26/24	Wrote 'MRI-Compatible Motion Platform' section in 'Methods' & 'Results & Discussion' for Preliminary Journal entry	1.0		
	2/27/24	Edit Preliminary Journal with team	2.0		
	2/28/24	HIPPA Training	1.0		
	2/28/24	Reprint Gearbox	0.5		
Amber	1/26/24	Semester planning with team	1.5	8.0	24.5
	1/31/24	Client meeting	0.5		
	2/1/24	Controls research	1.0		
	2/2/24	Review Motor Documentation	1.0		
	2/2/24	Create preliminary presentation slides	0.5		
	2/5/24	Implement changes to code	1.0		
	2/6/24	Draft PID algorithm	0.5		
	2/7/24	Review and practice preliminary presentation w/ team	1.0		
	2/14/24	Started MRI certification	0.50		
	2/15/24	Ran motor code test	0.50		
	2/15/24	Analyzed results	0.50		
	2/15/24	Updated code	0.50		
	2/16/24	Team meeting to clarify sinusoidal motion equation (Velocity & Position)	1.0		
	2/19/24	Meeting with Dr. Nimuncar to discuss sinusoidal motion function	0.5		
	2/20/24	Edited sinusoidal motion function	1.0		
	2/21/24	Tested & edited sinusoidal motion function	2.0		
	2/21/24	Watched GEHC MRI safety video	1.0		
	2/22/24	Test sinusoidal motion function	1.0		
	2/22/24	Background research on Journal Article	1.0		
	2/23/24	Drafted report and printed prototype with team	1.5		
	2/24/24	HIPPA Training	0.5		
	2/25/24	Wrote Motor and Testing sections of report	0.5		
	2/25/24	Competing Design Journal Research	0.5		
	2/27/24	Circuit Design Meeting	0.5		
	2/27/24	Edit Preliminary Report	2.0		
	2/28/24	Circuit Calculations	1.0		
	2/29/24	MRI Safety Book	1.5		
Jamie	1/26/24	Semester planning with team	1.5	7.5	19.5
	1/31/24	Client meeting	0.5		
	1/31/24	Researched organ motion	0.5		
	2/2/24	Worked on Preliminary presentation	0.5		
	2/5/24	Completed budget slide	0.5		

	2/6/24	Completed timeline slide	1.0		
	2/7/24	Review and practice prelim presentation	1.0		
	2/8/24	Researched Plastic Screws	0.5		
	2/14/24	Met with team to order screws, and calculate gearing ratio	2.0		
	2/16/24	BPAG meeting	0.5		
	2/16/24	Team meeting to clarify torque transmission	1.0		
	2/21/24	Researched potential journals	1.5		
	2/21/24	Watched MRI Safety Video	1.0		
	2/22/24	Solidworks modifications to gears	2.5		
	2/23/24	Drafted report and printed prototype with team	1.5		
	2/26/24	Wrote characterization of motion and sinusoidal motion test sections of report	0.5		
	2/27/24	HIPPA Training	0.5		
	2/27/24	MRI safety reading	0.5		
	2/27/24	Edit preliminary report	2.0		
Kendra	1/26/24	Semester planning with team	1.5	10	16
	1/31/24	Client meeting	0.5		
	2/1/24	Researched transfer function	0.5		
	2/2/24	Review motor documentation	1.0		
	2/5/24	Edited preliminary slides	1.0		
	2/7/24	Review and practice prelim presentation	1.0		
	2/14/24	HIPPA training	0.5		
	2/26/24	Caught up on meetings	0.5		
	2/26/24	Downloaded, read, and ran new code	0.5		
	2/26/24	Wrote introduction to preliminary report	1.0		
	2/27/24	Circuit design meeting	0.5		
	2/27/24	Edited preliminary report	2.0		
	2/28/24	Watched MRI safety video	1.0		
	2/29/24	Read MRI safety manual	1.5		
	2/29/24	LP non inverting amp circuit equations and circuit draft	1.0		
	2/29/24	Completed design journal research	2.0		
Caspar	1-26-24	Semester planning with team	1.5	1	10.33
	1-31-24	Client Meeting	0.5		
		Researched organ movement in MRIs	0.75		
	2-2-24	Team Meeting	1		
	2-6-24	Worked on Presentation Slides	1.25		
	2-7-24	Preliminary Presentation team meeting	1		
	2-8-24	Researched Plastic Screws	0.75		
	2-14-24	Finalizing Plastic Screw and Nut	1.25		
		Research, Met to work on gearbox			
	2-16-24	Team Meeting	1.0		
	2-17-24	Journal Types Review	0.33		
	2-25-24	Preliminary Report	1.0		